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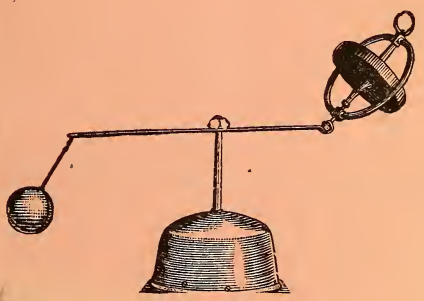
A THEOREM

ON

PLANETARY MOTION;

OR

SUNSHINE AND SHADOW.



By Clark Roberts, M. D.

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ST. LOUIS, MO.:
PRESS OF SLAWSON AND COMPANY,
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Proposition and Preface.

Theory is speculative; a doctrine or scheme of things; an exposition of any Science—the Science distinguished from the Art. A Theorem is something to be proved. We here adopt the latter term, and have attempted to work it out. How well we have succeeded in our task we will leave the reader of the following pages to judge, hoping he will bear with our foibles, and will consider the points and proofs we have produced, bearing in mind that we have used only such material as came casually to hand in course of the common events of life. On this account we have been compelled to render this essay more brief than the subject would seem to demand; but "Such as I have, give I unto thee," in as concise a manner as the nature of the subject would permit, assuring you that such has been our observations and reflections in our converse with nature and the laws of matter, as to almost compel us to commit our conclusions to paper, and finally to give them a publication for the consideration of such others as are disposed to speculate in thought or otherwise on matters of the nature of which we have written, and upon which we have so frequently pondered and reasoned so abstractly. If our evidences have been properly chosen and judiciousiy applied so as to be satisfactory, we have accomplished our design. But, if they are faulty or erroneously applied, then it is the privilege of such as will, to supply the defect or to correct the error, as the case may demand. Our greatest desire has been, and is, to produce facts, without fiction or guess-work; and that those facts may be so arranged and brought before the mind of the present age as that the youth thereof may be benefited thereby.

The Author.

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THEOREM.

Motion consists in a continued change of place, in regard to a fixed point, and is the result of force, either inherent or applied, and may be direct or indirect, primary or secondary. Gravitation is a direct inherent force of the primary order. Rotation is the result of force applied, and is of the secondary order, as in the case of weight added to one side of a rotund body, that is well balanced on its central axis, so as to move with ease in either direction. Such body will always be found to rotate in the direction of added weight, which there becomes a force, resulting in the rotation of the body acted upon, and is therefore the rotating force of that body. Hence we speak of the movement as the force of rotation. Weight withdrawn from one side of the body in motion and would be attended with the same result, and the waste consequent upon the extraction would require a supply equal to itself in order to sustain the motion; also a continuation of added force would be required on the other side. Then the two acting on the opposite sides would agree, and the motion would be perpetuated accordingly.

Force is a generic term, and in this case implies power in motion, or in a state of activity, as in the case of propulsion or ejection.

The Planets being composed of a mass of hetrogeneous material and perfectly inert, could never have acquired motion, unless acted upon by some force either primary or secondary, inherent or applied, or by both or all such forces combined, as by induction through the medium of external forces—such as gravitation, which we suppose to be mutual between all bodies, through an affinity of parts that inclines them toward each other, and thus determines a motion along the median line. Suppose we call this a concentric force, as it tends to draw both bodies to a common center. The others we may call a tangental force, from its outward action, and tendency to throw off at tengents

to its surface all around the circle of its own action; and in apposition to gravitation, to set up a centrifugal or projectile motion, which has a tendency to deviate both forces from their primitive course, and if their forces are equal, the line of the resulting movement would be midway between the two original movements, and the momentum would be vastly increased thereby; whereas if the primitive force of gravitation was to act alone and unopposed by an outward tending force, the sun by its immense size and centeral attraction would soon bring the scattered planets and their satelites together upon his surface, and a general collapse of worlds would be the inevitable result. But as the universe is arranged, the outward tending force of rotation acting in a direction at right angles to that of gravitation, not only sustains it in position, but increases the projectile power and momentum of the body many times more than either the gravitation or the rotation could seperately have produced.

Those two forces acting in different directions upon the same body do so combine their powers as to throw the planets upon lines of motion that never end, and have no abrupt change, and thus to develope in nature that harmony of motion, amid the vast expanse of systems suns and worlds with their satelites, as to insure an eternal round succession of times, periods and cycles forever.

Of gravitation as a force we have some idea, but of the origin, or cause of such a force we can only speculate or philosophize, and we are compelled at last to fall back on the idea of an inherent principle in matter as a solution of a problem so abstruse. While of the force of rotation when applied to the worlds we know as little as of any other force whatever, yet we have good reasons for knowing more, but have overlooked them in *speculative theories,* and finaly settled down on the idea of a *primitive impulse*, as the origin of all these forces, and now ascribe all those movements to an "*original*" or a *primitive impulse,* communicated at the "beginning" "when first ushered into space." Such are the teahings of most of those who have written upon these matters, even to this age.

Wm. Burrett in his Geography of the Heavens, (p. 271), while speaking of the forces, says of them (the centripetal and

the catrifugal), "the one tending to the center of the sun, and the other in the direction of a tangent to its orbit, arising from the primitive impulse given at the time it was launched into space." "The former is called the contripetal, the other the contrifugal force."

What this primitive impulse consisted of, or how applied, few (very few) have attempted to determine, but from what has been written, we would be inclined to suppose it to have been of the character of a forcible knock, push, or throw by the hand of the Creator, or many have been by the breath of his mouth, blown out into space, (the latter would be the most plausible), rather than by the establishing of natural and inherent principles, or laws of ponderable or imponderable, chemical, electric, or electro-magnetic, or any other means arising in matter itself, by which to perpetuate rotation, projection and orbital momenta.

But nature's laws and forces are ever constant in cause as well as in effect. There must, therefore, be an as efficient a cause for the rotation of the earth and other planets on their axes and in their orbits, as there is for their gravitation, or for the succession of day and night, or summer and winter where they occur. The movement of a body in space as well as in connection with another structure, can only be effected by physical forces, in an active state.

The attraction of gravitation is a universal force, ever constant and unvarying in its effect; always equalling the quantity of matter, and is as unvarying as the amount of matter acted upon —ever equalling the square of its distance and the amount of matter.

Rotation is as assuredly the result of force properly applied, as the contripetal force is the result of gravitation. In a recent work by Wm. Ogilby Esq., A. M., of Trinity College, Camb., etc., entitled a new theory of the figure of the earth, etc., and on pages 50, 51, I find him to say of rotation: "How or whence that rotary motion was communicated, we have no means even to conjecture." He continues: "Physical nature provides no force adequate to produce it, and we are therefore compelled to fall back on the idea of a great First Cause of the nature of volition, superior to, and unconnected with the material world." He

then continues: "Here at least we have direct proof of the commencement of a new epoch in the history of our planet; of a mighty revolution, produced by the agency of a non-physical cause which put an end to a previously existing order of things, and introduced a new world and new condition of existence," etc.

Such are the teachings of a professor of our own time and age, and on page 101, (same author) occurs a quotation from Laplace's Hypothesis, as follows:

"When a body receives an impression in a direction passing through its center of gravity, all its parts move with the same velocity; if this direction pass at some distance from that point the different parts of the body have unequal velocities and a motion of rotation is produced about the center of gravity, at the same time that this point itself is transported with the velocity which it would have acquired had the direction of the impression passed directly through it. This is the case with the earth and planets. Thus, in order to explain the double movement of rotation and translation, it is sufficient to suppose that the earth received its primitive impulse in a direction which passed at some little distance from the center of gravity; a distance which on the hypothesis of homogeneity would have been about the 160th part of its radius—about twenty-five miles."

Mr. Ogilby says of this, however:

"This assumption is evidently made in the interest of mathematical science alone and without reference to the principles of physical philosophy. It is one of the many devices by which analysts seek to generalize and consolidate their processes; but it is faulty in logic and contradicted by phenomena."

It will thus be seen that no one has yet discovered any law or force, other than "primitive impulse," by which rotation and the consequent projection of the heavenly bodies was produced, or is yet perpetuated.

Now it is a self evident fact, that there is a natural law in the construction of all material things, for the sustenance, propagation and perpetuity of the same; that said law does control, direct, and sustain the substance to which it is inherent; that this same law also originates with the substance itself, and accompanies it through the period of its existence; and where such a succession is necessary in the nature of the substance or thing, that the same law provides the necessary means for that end. So also in

the contruction of the inanimate, we find the same natural law as active and as constant as in the animate, and when we pass in observation to the eternal structures, the worlds and systems above and around us, we find the same universal laws sustaining, directing and controling all in their regular order; and we have but to search for and to find that or those laws, in order to comprehend their workings.

If I fail to find the light, that is no reason that I should say there is none, and deny its existence to others, because I have none in me. It is even so with Ogilbe and Laplace. They have searched for the cause, and failing to find it, have fallen back on a presumption that there is none, and hence ascribe all to an imaginary *primitive impulse*, and say there is *none other;* we are compelled to adopt this because we can find no other *cause.*

Let us return to nature's laws and scrutinize their workings a while and then decide for ourselves how this is. We inferred above that Nature's laws and workings were harmonious, and so we still contend. We recapitulate: There is a natural law in the movement of all the heavenly bodies, and for the perpetuation of all other things in nature, and that those laws were created at the same time with the creature or thing; and, as impulse is not a *law*, but a *force*—momentary, as it were, acting but once and then ceasing—it must follow, that a law for a continued movement was established at the same time of the creation. In this case a law harmonizing with that of gravitation and equally constant with it, would be required in order to the perpetual and proper motion of the heavenly bodies, and that that law produced the movement *then*, and has perpetuated it *since*, and will continue co-existent with the world's existence.

Our object in this present writing is to develope principles which may lead to the discovery of that law, to-wit: the law producing rotation, in the spheres; for in this, the law of projection depends for its support and perpetuity. An equally divided force applied to the opposite sides of a well balanced wheel and from the same direction could never produce rotation; whereas, if only a portion of the same force be applied continuously to one side only, the wheel will rotate freely. It is by the *increment* of force on the one side and the decrement on the other side of a well-

balanced wheel or round body, that the best examples of rotation are produced. Hence, if water be directed in a current upon a suitable wheel, near the top, and be allowed to fall off at the bottom, the motion will be in an exact ratio to the radius of the wheel and the stream of water; and the motion will be continuous and even. Here we would have a constant and equal amount of force on the one side, and the withdrawal of the water at the point where the force is expended; consequently a constant rotative force that is equal and even, and resisted only by the gravity of the rising side of the wheel and the friction of its parts in motion.

Now this is very similar to the action of the earth and other planets less the friction; for it is very plausible to suppose that the same means are at work on all those bodies, the primaries, at all events. Of the satelites or secondaries, we will have something to say elsewhere, when treating of their motions and forces. All projectiles are found to move in the air or through vacancy with their heavy parts in front, or foremost, while their lighter parts follow. Mechanics make use of this law in the construction of projectiles, as in gunnery and other mechanical devices where it applies, and have profited thereby.

We have many reasons for supposing that the earth and other planets are acted upon by forces not unlike that of the wheel and the projectile in the atmosphere or in space, which we will portray and delineate more at length further on; but for the present we will only say, it is our intention to bring to view forces that do produce effects on the earth and planets similar to those spoken of in the above remarks, to-wit: the producing of a heavy and a light side; the one upon the side of the earth that is moving in toward the sun, and the other on the side that is moving out from it, and all at fixed rates, and distances—always twelve hours apart—but ever constant in those relative positions; a heavy side always six hours in advance of, and a light side at the same distance always six hours behind the sun's apparent position in space at all times and in all parts of our circle of motion. The earth's or planet's rotative force must ever equal the sun's central attraction in order to perpetuate the orbital circuit of the earth or planet, and to sus-

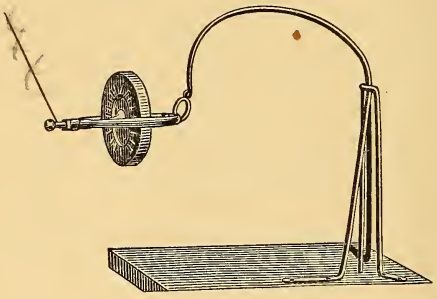
tain it there perpetually. Hence we perceive that the projectile force of rotation being equal to the sun's centrepital, or central force of attraction, they balance each other, and a perpetual and reciprocal action ensues, as the result. Hence, again, there must be as constant and never failing a source and supply for the rotation as there is for the gravitation, else this condition could not continue. This source, we think, we may find in the sun's ray, by its action upon the atmosphere, and water surface of the earth, and whatever we find here, in this respect, we may reasonably suppose to operate in like manner on all the planets.

Now, for the better illustration of this matter, we will here introduce, and explain the workings of the little instrument the *Gyroscope*, the force and demonstrations of which for so long a time severely taxed the brain of both hemispheres, until the secret of the motion was finally discovered by General G. J. Barnard, and was demonstrated and published by Doctor Levi Rubens (both of New York) in 1857. The article was first published in the June number of the *American Journal of Education*, of the same year, entitled, " Analysis of Rotary Motion as applied to the Gyroscope," which article will also be found in the *American Encyclopedia*. The article being too lengthy for insertion here, we will presently give merely a synopsis, in brackets, of the forces as given by Doctor Rubens.

Gravity being the first law of motion, and also being universal, holds dominion over all other forces; and inertia, the reverse of gravity, having no power to set anything in motion, nor to stop anything once set in motion, forms the two chief points to be considered in the movements of the gyroscope. Yet there is one other force that enters into the solution, without which the phenomenal action of the instrument could not be effected, to-wit: the force communicated by the hands.

It is upon this that the action depends for its support, which the resistance of gravitation gives the orbito-circular movement, and the rotation sustains the disc and ring, suspended in a horizontal position at the end of the axis, that rests upon the pivot, which sustains the whole weight of the instrument extended at right angles to the perpendicular of the support and base, the point of inertia. If the instrument be suspended by a crane, or otherwise

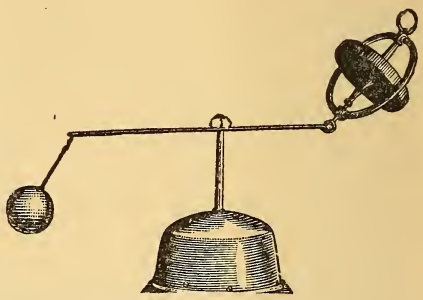
from above, and have a small swivel at the end, or point of attachment, the force and moment of action will be quite as free, and as well understood as when set upon the stile and base, and the danger of accident by falling will be avoided, while the movement will be more extensive, as it can here decline to the nadir point, without obstruction.



In our demonstrations we use one instrument that weighs two pounds and nine ounces, and another weighing one pound and thirteen ounces, of different construction, and of home manufacture, but of excellent workmanship. The one is mounted in a ring, as usual, the other in a sickle-shaped piece, as a support to the disc, thus showing that the ring has nothing whatever to do with the motion, other than as a support to the *disc*. This is really the one entire motor power in the instrument. Around the axle of the larger disc we wrap a cord or leather string, of four feet in length, which encircles it twenty-five times. This we withdraw in one second, thus giving the periphery of the disc a run of thirty-two feet per second. By this it may be seen that we double the speed of the falling force at the surface of the earth, which is but sixteen feet and a fraction for the first second. This, however, is an increasing force, while the motion we give the disc is a diminishing one, principally on account of the resistance by gravitation on the rising side of the disc in its rotations; but while the momentum of rotation is in excess of the momentum of gravity it is evident that the wheel cannot fall, but must incline toward the source of the resistance, to-wit: the rising side, which it will always be found to do. The whole weight now resting on the

pivot at one end of the axle, this now becomes the point of inertia, around which the momentum of rotation in the disc propels it, until the resistance of gravitation overcomes and reduces it to the speed of the falling force, at which point the axle assumes the vertical and the disc the horizontal position. Where the disc continues its motion for an indefinite length of time, this being governed by the size of the disc and the freedom of its motion, gravitation acts equally on all parts of the disc at the rate of $16\frac{1}{12}$ feet for the first second, and as it cannot fall, and the gravity speed cannot be increased, but the rotation produced by the hand communicates an additional momentum of another sixteen feet on the downward moving side, while at the same time, it overcomes and pushes upward the rising side against the force of gravitation at a speed of thirty-two feet per second, thereby throwing all the stress of the movement upon the rising side of the disc, to which it must now incline in order to equalize the two forces of gravitation and rotation in the body of the instrument; or we might say it is diverted from its central tendency in the opposite direction by the tangential or centrifugal force, and by these means they meet on grounds midway, and a circular motion is the result. With the instrument the earth is that gravitation point, and the pivot on which the instrument rests is the point of inertia about which it revolves, as the earth does about the sun as its center, and point of inertia. This movement cannot be brought about in any other way than by a rapid rotation of the disc in its proper place in the arrangement of which there is required to be a joint of free motion. This may be at the point of rest, or along the line connecting it with the rotating body, which, in the gyroscope may be of the ball and socket order, or by a small double-swivel, so arranged as to move freely in all directions. But with the earth and planets, space is sufficient; with the instrument the point of free motion, being at the end of the cross-bar, with a weight at the opposite end to balance the instrument, as seen in the engraving, the force of the rotating disc may be seen, when it is set in motion and adjusted in the socket, at the end of the bar, by the round head of the screw at the end of the axle. The other end being elevated as seen in the cut, and there left to

itself, it instantly starts off on a tour around the pivot, whirling the two-pound weight, bar and all, around in a lively manner, and, if hastened by the hand but slightly, it rises to the perpendicular; then, as the rotative force diminishes it gradually declines to the *nadir* point, where it continues in motion until its force is entirely expended.



[" One reason why the rotating body does not fall is that in such a body—wherever its plane is oblique to the vertical, gravity is no longer allowed to act singly, but must in every instance enter *into* combination with another force. Hence the body cannot simply fall, but must move toward such point in space as the combined actions shall determine, and furthermore, the same forces which ordinarily produce a vertical fall, here carries a body around in a horizontal circle, and sometimes even causes it to ascend. The weight of a rotating disc, however, is in all conditions sustained by the support and base on which the support rests." "In this explanation the distance through which the gravitative force acts, has been taken as very short, because by experiment and calculation it can be shown that, unless the weight of the ring and other attachments is very great, the whole downward action of gravity on the disc is very slight compared with that of the rotation first imparted by the hand, sometimes as small as in the ratio of one to forty, sixty, or more."]

This is Dr. Ruben's and Gen. Barnard's opinion, as given in the Encyclopedia. And it will thus be seen that rotation of the disc in the gyroscope is the principal force, next to gravity at least, and without which the phenomenon vanishes; but, with it, the exemplification of planetary motion is easy, and can be made quite clear and easy to be understood by most persons that have not been biased by previous speculative and incomprehensible theories.

It is presumed that few if any in this age, will question the rotation of the earth about its center of gravity as being the cause of the succession of day and night; and perhaps as few can give any reason for that rotation, or tell us upon what it de-

pends. Be that as it may, it is certain that few do pretend to give any other reason than that of a *primitive impulse;* and even on this, all fail to tell us how or by what means that *impulse* is kept in action, or continues to produce its effect so perpetually. Yet, to most minds, on due reflection, it will appear evident that in so constant an action, there must be as constant a cause or force at work tending to the end of perpetuating that rotation, and keeping it ever constant and equal, else the opposing force of gravitation would sooner or later have overcome, subdued and extinguished that rotation, and thereby have destroyed the equilibrium upon which the movements so evidently depend for their continuance and perpetuity.

Nature's laws are harmonious; certain causes are followed by certain effects. Those effects sometimes, nay, frequently, become causes of other and more stupendous results than the original cause had produced. A spark, the result of friction by flint and steel, may be the cause of exploding the mine; yet the spark as the effect of friction, when compared with the effects of the explosion, is very insignificant.

It has rarely, if ever, been hinted that the rays of the sun could possibly be the cause of so stupendous a result as that of the rotation of the earth and other worlds, that so evidently depend upon those rays for light, heat, electricity, etc. Yet, however hazardous it may appear, we venture the opinion, without scruscruple, that it is even so. And why not? We know enough of the sun's influence in many other respects, not to wonder at such being the case. We must acknowledge the sun's power and influence over all vegetable and animal existence to be such as that we could not live an hour without its influence. If it were not for the sun all things would at once relapse into chaos, and an eternal frigid night would be the result; but by *his* presence all is vivacity, light and life.

The sun is, undoubtedly, the prime moving force in this system, holding, directing, governing, and we might say, sustaining all by his presence and power. One half of our globe is constantly lighted up, (in a successive round), by his presence, while the opposite half is as constantly as deprived of his influence in a direct manner, thus perpetuating a succession of day and night, with all their advantages and peculiarities.

Mr. Lockyer, in his "Elements of Astronomy" says: "The sun's heat, and the earth's rotation on its axis, are, in the main, the causes of all atmospheric disturbances." p. 107, sec. 206. And on p. 112, sec. 215, he adds: "It is the presence of vapor in our lower atmosphere that renders life possible."

The sun's central force of gravity is well enough known, but the force that rotates to the earth and other planets, we think is not so well understood and by most persons is yet to be learned, even by some who have written extensively on physics and even on astronomy.

Now, while such force is not understood, or is ignored, there can be no clearness of view or definite expression in regard to either cause or effect. But with a definite knowledge of such force, all becomes clear and easy, and by the majority is readily received and is satisfactory.

In order to illustrate the rotative force of the earth, let us suppose a meridian line from pole to pole at all and every point passing over us through space, always visible at mid-day only. Then, as we rotate eastwardly, one-half of the twenty-four hours will be spent on the one side in passing away from that meridianal line, and the other half will be spent in returning by the circle in toward the sun, or in approaching the point from whence we started. In making this circuit we have traveled by rotation twenty-four thousand miles, twelve thousand of which removed us eight thousand miles farther away from the sun than we were at the starting-point, then by the balance of the circuit we are brought back to the starting point, eight thousand miles by a direct line nearer to the sun than we were at twelve o'clock last night; and we are here again with our line visible over our heads.

By this it is evident that one-half of our trip has been made in a direction in opposition to the sun's attraction or gravitating force and power, and the other half has been made in the direction agreeing with the attractions.

Now our globe is estimated to weigh six sextillion tons. One half of this vast amount is constantly moving out from the sun against his attraction; then, by a returning course, in toward it, as if in obedience to his attraction, in the same way and man-

ner as we have described our trip from noon to midnight, and from that to noon again.

Some theorists say: "the sun's equal attraction on both sides of the earth at the same time balance each other." If so, there could be no rotation from that source and we must search for another source of the force causing rotation to the earth.

In the philosophy of motion, if the attractions are equal on both sides, (which none will dispute), there must be a retarding force on one side, or an accelerating force on the other, or both, in order to produce rotation in a body of any size or form. Else there could be no rotation of that body.

Again, if a retarding force exists on one side, and an accelerating force on the other, then the forces would agree and the motion would be equally facilitated, and lasting as the forces are continuous; and if the body acted upon be free to move in all directions, it would incline toward the side of the resistance in obedience to that force, and would, therefore, be diverted from a direct projectile course as the result of rotation opposed by gravitation, and by this means a circular motion around the point of resistance would be the result, as is found to be case with the planets.

This resistance also determines the direction of the projectile, or centrifugal force, as it is called, from its tendency to propel the body in a straight line at right angles to the source of gravitation. The tendency of a rapidly rotating or revolving body to fly from its center in every direction is here determined upon a single point by this same attraction; but here the two forces unite in the circular action, and an elipsis is the result, which, like the true circle, has no end, but has a perpetually repeated motion in space, with an eternal succession of changes in speed, but without the least possible effect on the action of rotation. Observers have found the time of our earth's rotation not to have changed to the amount of the one hundredth part of one second in the last two thousand years, while the progression is constantly changing, as is evidently the case, every instant of time. When at aphelion the motion is least rapid, but from that point as it advances toward the perihelion, its force and motion are continually on the increase until the planet reaches that point; then, as

it turns around the sun and moves off on its outward course, it begins to loose speed, as before. This being a constantly repeated annual change, keeps the earth constantly on a change of speed. But not so with the rotation: the force that produces it is as constant as the rotation, and unchanging in character.

As yet it appears unsettled in respect to this force or movement of rotation, especially in regard to its origin, and the cause that produces it and keeps it in so constant and unvarying a condition; but it has generally been attributed to an original or *primitive impulse* communicated by the hand of the Creator in ushering it into space. This theory is as unsatisfactory as it is arbitrary, and implies that the planet was first created outside of *space*, and that on being ushered *into space* it was given a rotary motion by an impulsive force, that is to be perpetual, lasting, and coequal with the existence of the planet itself.

Now, an impulse is not a permanent force but an instantaneous influence, lasting but a brief space and then ceasing, and in the nature of things cannot be a permanent and continuous force. Therefore, "we look for another;" and for this purpose let us see what we can discover as an operative force in the sun's light and heat shed upon the earth in the form of his rays.

The sun's presence is always attended with an increase of heat, and by the expansion of most substances upon which his rays fall. Many things are entirely changed in point of character and condition. Solids are reduced to fluids, fluids are vaporized and caused to float off in the current of the atmosphere, or are entirely volatilized and dissipated. Clouds are the result of the vaporization, by the sun's rays falling upon the waters of the oceans, lakes, rivers, marshes, and other wet surfaces. Vapor, in a general sense, is an invisible, elastic fluid, rendered aeriform by heat, and capable of being brought back to the fluid or solid state by cold. It is in this sense we use this term. Clouds are partially condensed vapor; fogs and mists are the results of still greater degrees of condensation; but when it reaches the point of rain it has returned to the fluid state, and is falling drops of water. The next few degrees of cold would result in snow or hail, as frozen water from the clouds.

The mind of the young reader may now be better prepared for the following brief statement:

As the sun's rays are being constantly shed upon the one-half of the earth that is turned in his direction, all parts of the earth have an average of twelve hours of day on that side, succeeded by twelve hours of night; so that the sun, by his light and heat, is constantly evaporizing *water* on that side upon which his light is falling—according to Johnson's and Maury's computation by the rainfall of one year that is equal to 111,513,600,000 tons every hour. And this vast amount is not all; as Maury, in his recent Geography of the Heavens, so clearly shows, but this is enough for our purposes. Now, this is not for one hour only, but is the perpetual waste on one side, and return on the other, of water evaporated during the day and returned in the form of rain, the most of which is returned on the night side, while all of it is the result of the sun's rays on the day side of the earth, that by its diurnal motion is constantly moving out from the sun's central attraction, while on the other, or opposite side, which is moving in toward the sun at the same rate and speed, about two-thirds of the condensed vapor, in the form of rain, is falling in upon the surface, thereby adding the major part of the above-mentioned one hundred eleven billion, five hundred thirteen million, six hundred thousand tons, every hour, for the sun's attraction to act upon, on the side that is now turning in toward his center, and thus assisting in the grand process of perpetual rotation of the earth on its axis. This may have been incidentally inferred from the tables of Johnston and Maury, elsewhere referred to, but are not fully brought out in detail, as their tables refer to the quantity of water, and have no particular reference to the earth's motion.

It would not at first, appear probable that there is twice the amount of rainfall by night as there is by day, nevertheless our observations for the past nineteen months show it to be so. Our tables for nineteen months ending Dec. 1st., 1881, recording the rainfall from six a. m. to six p. m., and per contra, show this to be the average during the time as above given, which is the length of my record and gives me sixty-five inches for the total. Of this, forty-two inches has fallen during the night period, and only twenty-three inches by the day period. I am satisfied from observations I have taken of this matter that at eight in the morning and eight at night would be the correct

time to divide by, as that time in the morning is as early as the sun's influence is sufficiently established for a current of vapor to arise by his heat; while eight at night is as early as the vapor would cease to arise from the effect of the day's heat, or by the cooling off of the waters at night. Therefore I shall hereafter enter my records at those hours. The difference will be very small, but I think will be more correct as a standard to be governed by.

It is true that we, here in Winchester, Scott County, Illinois, have not had our usual amount of rain, but even with this amount the difference is so perceptible as to surprise most men when their attention is first called to it; and it is astonishing to most persons, that it has not been noticed by observers before this.

The amount of the rotative force arising in the above causes, is so vast as to utterly astonish most persons when first comprehended, and few would be willing to volunteer such a statement, yet it will be found to be true by such as will fairly investigate the matter for themselves.

Johnston, in the article above quoted says: "The annual rainfall in the five zones is equal to a depth of five feet over the entire earth;" and Maury says—"It is sufficient to fill a lake twenty-four thousand miles long and twenty-three thousand miles wide to the depth of sixteen feet." Now the length of the lake given is equal to the circuit of the earth at the equator, and if we divide the width by the days of the year, (365,) we have a quotient of eight and a fraction, which fraction together with the fraction of a day we will drop or cancel for brevity's sake, and we have the equivalent of a lake eight miles wide and sixteen feet deep extending entirely around the earth at the equator, as the rainfall for each day in the year.

Now let us divide this by the hours in the day, twenty-four, and we find that we have the equivalent of one thousand miles of this lake eight miles wide and sixteen feet deep for every hour of the day and the night also. This it will be found is equal to one hundred and eleven billions, five hundred and thirteen millions, six hundred thousand tons per hour, continuously.

Now let us see what some scientists of our own times have said of Vaporization, and other matters connected therewith:

Professor John H. Tice, of St. Louis, Mo., has given us the most thorough and best account in detail of this process, that it has been our fortune to meet with. He, in the course of his remarks says:

"The vapor that forms the clouds which distil the rains that water the earth, filling the rivers until they overflow, and clothing the fields with verdure, comes from evaporation on the surface of the ocean." "At the city of St. Louis fully one thousand miles from the ocean, whence the vapor comes, the rainfall on each acre averages about seven thousand tons annually, or about 7,000,000 tons to the square mile. The amount of rainfall in the State of Missouri, hence, is over 300,000,000,000 tons annually."

"Now this enormous quantity of water is not only vaporized over the ocean, but is transported a thousand miles into the continent, and then raised to an elevation of from two and a half to three miles above the earth. When the amount of rainfall in Missouri is supplemented by the quantity that falls in the adjoining States in the Mississippi valley alone, the quantity is so stupendously great, that the human mind is utterly incapable of conceiving an adequate idea of it. This inconceivably great quantity has to be augmented by the rainfall over the globe to obtain the total amount of work done by the Solar Energy in vaporizing water and in raising and transporting it to all parts of the earth. Add to this the weight and volume of air moved by drawing down and propelling it along the surface of the earth and then hoisting it up again—an amount of work requiring an expenditure of far greater energy than the forestated aqeuous movement—and even then we have not the total amount of Solar Energy expended upon the earth and its atmosphere. But taking transportation and elevation alone, as to distance, weight and quantity, and we have so stupendous an amount of work done by the sun, that the whole human family, all the oxen, mules, horses and steam engines in the world, could not perform one millionth part of it. With these facts staring us in the face, why should we ask what becomes of the energy of the sun that is shed upon the earth in the form of light? The inquiry is what becomes of the light shed by the sun upon the ocean? A part of it, perhaps all of it, becomes transformed into heat, but if so then it does not persist long enough, as heat, to become sensible as such, but according to the universal law of dual evolution, electricity is simultaneously evolved with heat; but why does not heat accumulate and the water-surface of the ocean become as hot as the land? The answer is, that, whichever may be the case, whether the transmutation of light be immediately into constitutism, or mediately through heat, the final result is that the light passes into the constitutive force and its accompaniment, electricity, which is necessary to form the incessant stream of vapor issuing

from the ocean, like from a great cauldron, and spreading itself over the whole globe. This stream of vapor forms clouds in the sky whose rains water the thirsty land, giving fertility to the soil and clothing the continents with verdure."

The Professor goes on, very correctly, to say:

"Operations upon so gigantic a scale, so uniform, so universal and ever efficient, cannot take place casually; but they must be inevitable consequences of natural agencies, established and incorporated in the constitution of the universe. Efficient causes must not only be established there, but natural affinities between force and matter that work in harmony with those causes, facilitating their operations and ensuring their efficiency" in all things.

Those remarks of Professor Tice are of such importance and so true, as to preclude all necessity for comment; we, therefore forego the attempt.

We have now collected an amount of evidence of a force or forces, superior to and beyond the power of most minds to comprehend. Our next effort shall be an attempted application, and an elucidation of those forces for the better view and understanding of those who wish to further investigate the workings of nature's laws and forces.

On our first page it is stated that motion consists of a continued change of place in regard to a fixed point; and that it is the result of force. In planetary motion, the sun is that fixed point, in regard to which the earth is constantly in motion, both by rotation on its axis, and rovolution in its orbit around that luminary. The force that produces these motions has, in our opinion been faithfully portrayed in the remarks of Professor Tice, as above quoted, and only require an application, to show how it is done.

It may be essential that we here call to mind the fact that one half of our globe is in a regular rotative order under the sun's rays, and thus receiving his light and heat, the effect of which is an expansion of most substances rendering them specifically light, as well as the vaporization of the vast amount of water as above stated, from that side; and the attraction of the sun is as constantly more effective there, as it is eight thousand miles nearer to the side that is next him than while on the opposite or right side that is now turned from his presence; and the direc-

tion of the attractions on that side being now in the opposite and central direction, has its effect also, while the current of the atmosphere is constantly in the same direction as that of the rotation and moving at a greater rate of speed (by about an average of ten miles an hour), so that the vapor raised by the sun's light and heat is wafted forward in the line of rotation faster than the surface of the earth moves by rotation, thereby assisting in the processs of the rotatory motion, not only by moving the amount of water approximately mentioned above, from that side as so much material, but by transporting it forward faster than it would have gone by rotation.

If it were not for those movements, the two sides of the earth east and west of the mid-day meridian would be equally balanced, and the sun's central attraction, by its equal force on both sides, would soon put a stop to, and end the rotation, by bringing the earth home to itself. But by relieving the receding side of the enormous amount of 111,513,600,000 ton's weight per hour, and allowing a similar amount to be added to the advancing side, the attractive force on the two sides becomes unequal and rotation is the inevitable result.

An equal amount of attraction by the sun upon all parts of the earth on which the light is falling at any one time, precludes the possibility of rotation by that force alone; but when we consider the effect of evaporization in connection with gravitation, the tables are at once reversed; for gravitation exerts its force on all parts in an exact ratio to the amount of matter and the square of its distance; but in rotation, one side of the revolving body is found to be moving in the same direction as that of its gravitation, while the opposite side is as constantly moving off in the opposite direction and in resistance to the gravitating forces. It necessarily requires much more force to propel the outward and upward than it does the inward and downward tending sides of so large a body as the world. These are facts any person who is not biased by previously received opinions, can see and comprehend.

But as there are those who will cling to old theories; and we, therefore, wishing to reduce this essay to a worked out theorem, by proving our positions, have taken the liberty of quoting

to some extent, authors who have written without any view or expectation of being referred to in the light to which we have applied their remarks. Nevertheless their writings are none the less valuable for our purposes.

With the evidence of such facts and forces as those referred to before us, and when nature herself provides such vast means for observation, how can any one deny their legitimate effect, and fall back on the idea of an *impulse* force in lieu thereof, for our our rotation and consequent projection in space, is to us a problem past our solution.

It is true that but a few years have passed since suitable instruments for observing and tabulating the amount of rainfall, together with the processes of evaporization of water by the sun and the recondensation by its absence have been invented, and the the process known; but as we are now in possession of those facilities and facts, it does appear to us that we ought to make use of them in the establishing of plausible theories, and to the obliteration of such indefinite and undefinable expressions as that of an "*original primitive impulse,*" *&c.*, and thus by lopping off those *primitive* ideas and supplementing them with practical teachings of physical laws and the operation of the forces of nature, directing the mind of the rising generations in a new and better channel of thought, the better to fit them for usefulness in life.

Observation has determined the rotation of our earth at the equator to be one thousand miles to the hour: here in the north temperate zone it is not quite so much; but it is here about seven hundred and seventy or eighty miles to the hour. To this add the average velocity of the wind in an easterly direction at ten miles an hour, and it will be seen that the vapor will, (as above stated), be wafted forward of the earth's motion, and in the same direction with it, thereby rendering the side of the earth that is now moving out from the sun, *light*, by the amount of the water evaporated, as above shown. For it is clear that, as the sun is the fixed point in regard to the earth's motion, so, therefore, to any given point on the earth's surface where the sun is at meridian, all that side or portion of the earth eastward of said meridian, will be moving away or outward from the sun, and all that portion west of that point around to the nadir must be

turning in toward the sun at the same rate; so that at the nadir or midnight point, now eight thousand miles farther away from the sun than when at the zenith or noon point, the sun's influence or force, will, in all respects, be less effective. All solids will there be more compact, because of the loss of heat; fluids will tend to the point of solids; vapors to condensation, and the form of fluids, and all things to an increase of specific gravity by contraction. Therefore, that side of the globe will become more subject to the sun's attractive force, by the amount of increase in specific gravity, as well as in quantity of material, because of the sun's central attraction; while the opposite side, to the amount of water vaporized there, will be rendered light, and will thus act as a rotative force to the earth. And indeed, we have every right to claim both as rotative forces.

And, in addition to all this, the force and direction of the sun's attraction is also deviated, so that at night it agrees with and is in the same direction as that of the earth, so that all floating material in the atmosphere or on the surface of the earth has the attractive influence of both sun and earth in the same direction, thereby vastly increasing its tendency to return to the surface of the earth; whereas, during the day, the attractions being in opposite directions, floating material would necessarily be influenced accordingly.

But of the sun's influence upon our atmosphere, I will quote from Lockyer's Elements of Astronomy, page 108, sec. 208, as follows:

"Now, how are the winds set in motion? The equatorial regions are the part of the earth which is most heated; consequently the air there beomes rarified and ascends, and a surface wind sets in toward the equator on both sides to fill its place; these are the trade winds. The air thus wafted toward the equator is soon itself heated and ascends, and accumulating in the higher regions, flows as an upper current toward either pole, thus are produced the anti-trades which in the regions beyond the calms of Cancer and Capricorn, descend to the earth's surface. The equatorial belt some five degrees wide, in which the heated air is constantly ascending, is remarkable for daily rains, often accompanied with thunder and lightning."

Section 209:

"If the earth did not turn on its axis we should still have the

trade-winds, but they would blow due north and south from the poles to the equator. Their direction is modified by the earth's rotation. Coming from higher latitudes with the less rapid rotary motion which there belongs to the earth's surface to the equatorial regions which have a more rapid motion, the earth, as it were, slips from under them toward the east and the winds lagging behind, *though really themselves also moving eastward*, appear to come from the East, forming north-east winds north of the equator, and south-east winds south of it. In like manner the anti-trades endowed with the more rapid rotary motion of the equator as they go toward the poles, arrive at regions where the rotary motion is less rapid; the *earth's* surface, therefore, now lags behind, and the winds appear to blow, as they really do, toward the East, forming south-west winds in the northern hemisphere and north-west winds in the southern."

Section 210:

"It is the sun, therefore, that sets all this atmospheric machinery in motion, by heating the equatorial regions of the earth."

Article 206, last clause:

"The sun's heat and the earth's rotation on its axis are the main causes of the atmospheric disturbances."

So much for Mr. Lockyer.

Now let us see what Mr. Maury, of our own time says. On page 44, of his new Physical Geography of 1881, you will find him to give utterance to the following:

"In studying the operations of the physical machinery you will find that the principles of action and reaction, and the powers of antagonistic forces play an important part in it, as they do in our system of mechanics. The harmonies of nature pursued by antagonistic forces. By them the earth is hung upon nothing, and sent whirling through space. The animal and vegetable kingdoms derive their powers from the harmony of their discord, for each lives by undoing the work of the other."

He again, while speaking of the sun's influence, says:

"Heat is the great motive power of the world, and the sun is the great center and source of it all. His warmth keeps the sea liquid, and all the storms which agitate the waters derive their power from him: He lifts the rivers from the sea, and builds the glaciers upon the mountains, and thus the cataract and the avalanche shoot with an energy derived from the sun. All this power displayed on the earth is but the two billion three hundred millionth part of that which is continually exerted by the sun, for this is the portion of his rays

which, as he darts them out in all directions, are intercepted by the earth."

Now let any one who will compare those facts with the conclusions we have elsewhere already advanced, and we think they must be satisfied and convinced of the truth of our proposition.

But to return to the secondaries of which we will take our moon as an example. Here we have a compound, and to some extent a complicated or double motion; and on close examination we find the forces to be of the same character, and just what we might have expected and looked for from the results. But on consulting Mr. Lockyer, we find him to say on page 277, article 506:

"The moon's orbit is an exact representation of what the path of our cannon ball would be at the moon's distance from the earth." * * * "In fact, the moon's path is the result of an *original impulse* in the direction, at right angles to, and a constant attraction toward the earth."

Here we would ask Mr. Lockyer what becomes of the sun's attraction upon the moon in this instance? We suppose, however, he has declined it in favor of the primitive impulse; if so, we ask what reason he has for so doing? Hence, we again suppose he does it for the same reason that Ogilby gives for the earth's rotation—"Seeing that he could find no force in physical nature adequate to that end." But in this case, it appears to us there is ample proof of a sufficient force for that end, and to that purpose, in the double attractions of the sun and earth on one hand and their separate attractions on the other hand, upon the moon itself in its double orbital movements around the earth, and along with it around the sun as it is known to do. Much as we admire the writings of Mr. Lockyer we cannot approve of his idea of a *primitive impulse* in regard to the moon's action and of the "cannon-ball" movement he refers to.

Now this movement of the moon and earth together around the sun is evidently the result of the double attraction as above stated. The earth and moon are always, at any point in the earth's orbit, moving at right angles to the sun's center and the earth's position in its orbit, while the moon has an eliptical orbit around the earth also, constituting the earth its centripetal point

and the sun as its centrifugal tendency, keeping it from falling into the earth; much as our earth's force of rotation by its centrifugal tendency keeps both itself and the moon from falling into the sun.

The earth and the moon are traveling as it were together, in the journey around the sun, at a mean distance of about 93,000,000 miles from it. This circuit they perform in one year during which time the moon passes around the earth in the same direction, from west to east nearly thirteen times, at the distance of two hundred and forty thousand miles from it. The moon, therefore, must move much faster through space than the earth does in its orbitular circuit around the sun. Burrett estimates it to be fourteen times that of the earth in its orbit. This is greater than we make it, but it does certainly move much faster through space in its compound motion than any other body known to us. Its motion, too, is very irregular, as on one incline around the earth it loses in speed so as to fall back behind the earth, while on the other side, it out-speeds the earth so as to overtake and pass by it, making an increase over the earth's speed, in the amount of the full diameter of the circle of its orbit in one half of its circle around the earth.

Now, all this change in speed and of position, happens about as follows: The sun's attractive force on the moon and earth is estimated to be as seventeen is to forty-one nearly and relatively as above stated; and, while the moon is between the sun and earth, it is attracted in opposite directions in the ratio of the above figures; it therefore slackens in speed, but is still passing forward in the direction of the earth's orbit, and is attracted in that direction by the sun's influence; but as the earth is following just behind, it is by the amount of its attractive force, pulling the moon in toward itself in the ratio of its force; thus acting upon the moon as a retarding force until it circles around behind the earth where the moon now receives the full force of the earth and sun's attractions jointly in the same direction, and is thus pulled forward at an increased speed; while as it passes the earth on the outside of its orbit it is being held in by the earth's sidelike force and turned in a circle around between it and the sun, as before. This is in a perpetual succession, always with the same side of the moon toward the earth.

Now as all unequally balanced bodies are found to pass through the atmosphere, or through a liquid medium, with their heavy parts in front, and as the moon is more under the direct influence of the earth's attractive force than it is of that of the sun, and seeing that it always presents the same side toward the earth, and is perpetually passing in a curve around us, with no other motion of rotation than that produced by the orbital circuit, it appears very plausible to suppose it to be of an unequal weight in the direction of its orbital diameter. Then as the earth is its centripetal point and the sun its centrifugal force, her eliptical motion about the earth, without an additional force by rotation, becomes a natural and an inevitable result; and as there is no evidence to the contrary, we claim that it is very reasonably thus situated. Consequently, in this case, there is no call for an *impulse* force, primitive or otherwise, and with Steele we would say: *"This careful fitting, whereby the plan is always modified to accomplish an end, is everywhere characteristic of nature, and is a continued revelation of its common author."

Then, to recapitulate:

The sun's force, by his attractive power on the earth and moon *is found to be as 41 to 17, relatively.* The moon being only 240,000 miles from the earth, and averaging only this same amount of being ninety-three millions of miles from the sun, the earth being thirteen times the size of the moon and 400 times nearer to it, must evidently exert much more influence over the motions of the moon by the square of their distances than the sun does in a direct manner. The moon, therefore, moves about the earth as its center of motion, but still is obedient to the sun's influence to the extent of his attractive power and distance, which is just sufficient to fill the measure of her centrifugal force.

The moon, too, is found to be void of water, and consequently of an atmosphere; therefore it could not rotate on its axis as the planets do, by the forces we have suggested in the former part of this essay. Our satelite, therefore, evidently circulates without an axial rotation, save only by a circuit with its most ponderable part foremost, as structures are found to do in our atmos-

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* Steele's Astronomy, page 176.

phere, and are supposed to do so in space. The void through which the earth and moon are passing does not destroy gravitation; it only modifies it by the amount of matter, and the square of the distances. The body, therefore, presents its most heavy parts to the attractive force, and the lighter parts lag behind in obedience to the ethereal elements that are supposed to fill all space.

But, to proceed to the conclusion:

We have shown by the gyroscope and a synopsis of Doctor Rubens' and Gen. Barnard's demonstrations of its movements, that rotation in connection with gravitation, when acting through proper media and upon a suitable body, necessarily result in a circular movement similar to, and with a traveling force and momentum of action very much resembling the motions of the earth and other planets, or we might say, the rotation of the disc in connection with gravity, results in a movement which, when applied to the earth, represents its annual motion round sun; the rotary force meeting with the resistance of gravitation at a certain point in the rotation, in such a manner as to deviate the body from a direct tendency, and thereby to set up a traveling movement midway between those two forces, and thus to propel it around a point of inertia outside of its own body, and at a distance from its surface; and thus to sustain it in an orbitular circuit, and while the rotative force continues proportional to that of gravitation the movement is continuous and uniform.

By the quotations from Professor Tice, we have shown the process of evaporization of water by the sun from the ocean and by what force it is raised and transported to all parts of the earth, and in such vast quantities as to outvie the human mind to conceive an adequate idea of it; and that the process has been carried on in such a silent and unobtrusive manner as not to have been detected or even suspected by man, in all the many thousand years he has been a dweller on earth. We have shown by Johnston the annual amount of water returned to the earth by the process of condensation to be equal to five feet over the entire earth, and that Maury computes it to be sufficient to fill a lake of the length of twenty-four thousand miles and three thousand miles in width, to the depth of sixteen feet annually. Now, an easy process will show this to make an average of 111,513,600,000 tons per hour

continually, and this not the full amount vaporized by the sun, but only the amount recondensed and returned to the earth in the form of rain only, while mist, dew, vegetable absorption, &c., is not there included.

It must also be remembered, that all the vapor that forms the clouds from whence the rain comes, is the work of the sun's light and heat shed upon the earth and seas by day, without which there would be no clouds, nor rain to fall, by night or by day. Then again, as is evident from my rain table as above shown, there is twice the amount of rain during the night to what falls by day. By this it will be further seen, that all the vaporization is done on that side of the earth that is, by its rotation, moving out from the sun; and this, together with the increase of specific gravity on the opposite and inward tending side, by contraction of solids from loss of heat; the condensation of the vaporized water, by the shades of the night and return of most of the same to the earth as ponderable and uniform forces for the sun's attraction. All this we have shown to be and to act as powerful rotative forces on the globe, and it is to this influence, by the presence of the sun on the one side, and the shades of night on the other, we claim the title of "Sunshine and Shadow."

In addition to all this we have shown the direction of the earth's rotation; the general current of the atmosphere's movements, of clouds and general direction of rain and storm centers to be eastwardly, and hence the right application of all as rotative forces to the end that they all favor rotation in that direction. And further, it is asserted by most observers that all the primaries are acted upon and influenced in their movements by the same or like forces; that they all contain large bodies of water, and of course have an atmosphere as our world has; that they also rotate and revolve about and around the sun, as our world does, and no doubt, by the same or similar forces; and that the satelites follow and obey similar causes and forces with similar motions to ours in all respects, and therefore, they only rotate by an axial rotation, once for each revolution around the primary, as our moon does, in passing around us once a month. Hence the same laws and forces we have given for our moon applies to them with the same, or similar force as to ours. The passing round

in a circuit is not really a rotation as on an axis, but is simply a revolution by a circuit. Our earth not only revolves on its axis, but it revolves around the sun also ; therefore it rotates and revolves by an axial daily, and at the same time a circular or yearly motion around the sun. This is really axial rotation and orbital revolution. Whereas the motion of the moon is only orbital around the earth monthly, and with the earth about the sun annually, and it therefore can hardly be said to rotate axillarially as the earth does.

Thus we have given and now present to the thoughtful reader our views and reasoning upon some of the principal forces and points in planetary motion. If our views are reasonable and philosophic we ask their acceptance and adoption. If they are erroneous and unphilosophic we ask their confutation by a fair and just presentation of facts without fiction or guess-work, that the community may be benefited thereby and posterity be saved from an error that might be lasting and detrimental.

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